Agent Persuasion Mechanism of Acquaintance

Wu Jinghua\textsuperscript{a}, Lu Wenguang\textsuperscript{b}, Meng Hailiang\textsuperscript{c}

\textsuperscript{a}Management School, China University of Mining and Technology, Beijing, China
\textsuperscript{b}Gengdan Institute, Beijing University of Technology, Beijing, China
\textsuperscript{c}Economics and Management Institution, Beijing Information Science and Technology University, Beijing, China

Abstract

Agent persuasion can improve negotiation efficiency in dynamic environment based on its initiative and autonomy, and etc., which is being affected much more by acquaintance. Classification of acquaintance on agent persuasion is illustrated, and the agent persuasion model of acquaintance is also illustrated. Then the concept of agent persuasion degree of acquaintance is given. Finally, relative interactive mechanism is elaborated.

© 2012 Published by Elsevier B.V. Selection and/or peer-review under responsibility of Garry Lee

Open access under CC BY-NC-ND license.

Keywords: agent; persuasion; mechanism; acquaintance

1. Introduction

Automated negotiation allows negotiation parties to conduct effective negotiations in the case of unmanned, remote off-site. It not only greatly saves negotiation cost, but also adapts to the rhythm of the rapid development of the global economy and promotes its rapid development. So it is widely concerned for its convenience and efficiency. However, it need the participation of negotiation has a high level of automation and intelligence which restrict its use. Autonomous agents, as an immerging technology are widely used in AI due to their characters of autonomy, initiative, and collaboration and are suited to negotiation.

Persuasive techniques \cite{2,3,4} aim to enable agents to achieve better agreements faster by allowing them to express, update, or revolve their preferences in single or multiple shot interactions. Compared with other techniques where in most cases, automated negotiation proceeds as a series of offers and counter-offers \cite{5,6}, it meets more needs of real life negotiation and tends to achieve a reasonable result \cite{7, 8, 9}.

Relationship of acquaintance is common in human negotiation. Particularly in the negotiations stalled, it often has a positive effect and makes the negotiations towards a more rational direction. Introduce acquaintance into agent persuasion can improve the quality of negotiation and bring new feature into persuasion and its evaluation \cite{10, 11, 12, 13, 14, 15}.
A number of approaches to persuasion have considered various aspects of the problem over the last few years. [7] Considered trust with persuasion of agent together, mainly built a relative model to study how to establish trust by persuasion. [8] addressed a belief-modification parameter based on multi-attribute utility theory, by means of calculating and comparing the parameter, it give a rank of belief and then propose an according persuasion method. Based on study of persuasion strategies, [9] proposed a formal model of threat, reward and appeal and its evaluation model, and developed a system to verify it.


Throughout these researches, [7, 8, 9] not considered acquaintanceship in agent persuasion. [10, 11, 12, 13, 14, 15] studied acquaintance from various aspect, seldom are involved in the negotiation, especial in persuasive negotiation.

Based on the above views, this paper will first gives a classification of acquaintance, then builds agent persuasion mechanism based on acquaintance and its interaction.

2. Classification of Acquaintance on Agent Persuasion

The classification of acquaintance is the basis of agent persuasion mechanism of acquaintance. So in this section, we first give a classification of acquaintance in agent persuasion.

Among current research of acquaintance, there are two classic literatures in classification of acquaintance.

- [15] Classifies acquaintance into two types: acquaintance ever interacted with and that not interacted with.

But classification of above two is not suited to agent persuasion. For example, classification of [13] is based on agent and the relationship between the system classifications. This will restrict use of acquaintance in agent negotiation area. Similar with human’s social character, agents are in community with complicate relationships. Having considered its social character and inspired by properties of agent persuasion proposed by [9], we give our classification of acquaintance of agent in persuasive negotiation:

- Acquaintance of relative. For example, in a family the relationship between a father agent and a son agent.
- Acquaintance of workmate. For example, the relationship between a manager agent and employee agent.
- Acquaintance of friendship.

3. Agent Persuasion Mechanism of Acquaintance

In this section, we first give a persuasion model of acquaintance, then concentrate on the interactive mechanism.
3.1. Agent Persuasion Model of Acquaintance

Suppose that a agent community is composed of three agents: AgentA, AgentB and AgentC. AgentA and AgentB do not know each other, but AgentC is acquainted with AgentA and AgentB. Now, AgentA is negotiating with AgentB for some particular product. Because there is sharp difference between AgentA and AgentB about the offer, and they are not known each other, negotiation locks in stalemate. In order to reach agreement, AgentC will give persuasions to AgentA and AgentB using its acquaintance relationship of AgentA and AgentB.

Take persuasion AgentC gives to AgentA, the persuasion model is a five-tuple listed below:

\[ \text{Per}(c \Rightarrow a) = (c, a, AR, S, \{AR \uparrow\}) \]

- \(c\) is the persuader, that is AgentC.
- \(a\) is the persuade, that is AgentA.
- \(Per(c \Rightarrow a)\) is the persuasion AgentC gives to AgentA.
- \(AR\) is the acquaintanceship of AgentC and AgentA.
- \(S\) is the persuade strategy selected by AgentC, such as reward or a threat, and \(S \in S_a\).
- \(AR \uparrow\) means that if AgentA accept the persuasion, it will improve the acquaintanceship between AgentA and AgentC.

There exists an relation in the model: \([AR \cup S] \rightarrow \{AR \uparrow\}\).

This model is also suitable when AgentC gives persuasion to AgentB which can be represented as:

\[ \text{Per}(c \Rightarrow b) = (c, b, AR, S, \{AR \uparrow\}) \]

Of which: \(AR \in AR_b, S \in S_b\).

To illustrate the model more clearly, we assume that in the negotiation AgentA is buyer and AgentB is seller. Acquaintanceship between AgentA and AgentC is workmate and AgentC is AgentA’s leader, that is to say, AgentA is responsible for AgentC (Leadership). Acquaintance between AgentB and AgentC is friendship (Friendship).

Now suppose that negotiation between AgentA and AgentB locks in stalemate. In order to reach agreement and maintain (or strengthen) the acquaintanceship, AgentC will send persuasion to AgentA and AgentB. AgentC select a reward strategy of promotion to the former Reward(Promote) and a threat strategy of breaking off relations to the latter Threat(Break). Persuasions can be formulated as below:

\[ P(c \Rightarrow a) = (c, a, \text{Leadership}, \text{Reward(Promote)}, \{\text{Leadership} \uparrow\}) \]
\[ P(c \Rightarrow b) = (c, b, \text{Friendship}, \text{Threat(Break)}, \{\text{Friendship} \uparrow\}) \]

3.2. Interactive Mechanism

To construct the interactive mechanism of persuasion, the first thing is evaluation of the persuasion, the second is modify the offer after receive a persuasion.

**Definition 1 (Degree of Acquaintance Persuasion)** during persuasion process, agent will use acquaintanceship to build some persuasion in order to reach agreement; this may make the agent in negotiation alter their offer. The influence degree of acquaintanceship to negotiation is called Degree of Acquaintance Persuasion.
Degree of acquaintance persuasion is the foundation of modification of negotiation offer, and it can be calculated:

\[ Degree(ARP) = \lambda_{AR} \times E(AR) + \lambda_s \times E(S) \]

\(Degree(ARP)\) is the degree of acquaintance persuasion; \(E(AR)\), \(E(S)\) is the persuadee's evaluation of acquaintance and persuade strategy; \(\lambda_{AR}, \lambda_s\) is corresponding weight.

Consider example above, when agent receive persuasion, it will evaluate the persuasion and get the degree of acquaintance persuasion and then alter their offer according formula listed below:

\[
Buy(Order) = Buy(Order) + Degree(ARP_{Buy}) \quad Sell(Order) = Sell(Order) - Degree(ARP_{Sell})
\]

First, assume offers of both sides and their weights are listed in table 1.

So evaluation value of offers is calculated:

\[
Buy(Order) = 0.4 \times 3 + 0.6 \times 5 = 4.2 \\
Sell(Order) = 0.5 \times 6 + 0.5 \times 7 = 6.5
\]

Second, data about acquaintance and persuade strategy and their weights are listed in table 2.

TABLE I. Buyer And Seller Order And Relative Weight

<table>
<thead>
<tr>
<th>Buyer</th>
<th>Seller</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>Qty</td>
</tr>
<tr>
<td>AgentA</td>
<td>3</td>
</tr>
<tr>
<td>AgentB</td>
<td>6</td>
</tr>
<tr>
<td>Weight</td>
<td>0.4</td>
</tr>
</tbody>
</table>

TABLE II. Each Value And Weight Of Acquaintance Relationship And Strategy On Agent Persuasion

<table>
<thead>
<tr>
<th>Acquaintance</th>
<th>Persuade Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workmate</td>
<td>Friend</td>
</tr>
<tr>
<td>AgentA</td>
<td>3</td>
</tr>
<tr>
<td>Weight</td>
<td>0.3</td>
</tr>
<tr>
<td>AgentB</td>
<td>5</td>
</tr>
<tr>
<td>Weight</td>
<td>0.6</td>
</tr>
</tbody>
</table>

Then the degree of acquaintance persuasion of AgentC to AgentA or AgentC to AgentB is:

\[
Degre_{(ARP)_A} = \lambda_{AC} \times E(AR_A) + \lambda_s \times E(S_A) = 0.3 \times 3 + 0.3 \times 3 = 2.4
\]

\[
Degre_{(ARP)_B} = \lambda_{AC} \times E(AR_B) + \lambda_s \times E(S_B) = 0.4 \times 3 + 0.6 \times 5 = 4.2
\]

Purchase offer of AgentA then is modified as below:

\[
Buy(Order) = 4.2 + 2.4 = 6.6
\]

And sell offer of AgentB is below:

\[
Sell(Order) = 6.5 - 4.2 = 2.3
\]

Finally, we can see that whether AgentC send persuasion to AgentA or send persuasion to AgentB, there also a relation exists: \(Buy(Order) > Sell(Order)\). So, the persuasion is successful and AgentA and AgentB will reach agreement quickly by AgentC’s persuasion.

4. Conclusion and Future Research

Compared with traditional ways of negotiation of agent such as proposal and counter-proposal, persuasion between agents can make negotiators exchange additional knowledge that can simulate the sensibility of human being besides such simple knowledge, which can make the negotiation to be continued with acceptance by both of them, and finally accomplish their cooperation with the biggest profit. Introduce acquaintanceship to agent persuasion can improve quality of persuasion and lead a better result for both sides.
Based on classification of acquaintance and concept of Degree of Acquaintance Persuasion, this paper proposes a persuasion model based on acquaintance. Compared with other works, persuasion mechanism in this paper illustrates effect of acquaintance more clearly and gives a relative simple method to quantify influence of persuasion using acquaintance, which reduce overhead of system and improve negotiation efficiency. In the future, this classification and model will be improved and integrated in real application.

Acknowledgment

Project supported by “the Fundamental Research Funds for the Central Universities(No.2009QG03)” and “the Project of Rising Research Level in 2010 year (No. 5028123500)” and “Beijing soft science research project – research on construction of knowledge innovation system in colleges and universities in Beijing area”.

References
